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MULGRES: A COMPUTER PROGRAM FOR STEPWISE MULTIPLE REGRESSION ANALYSIS

Abstract.—MULGRES is a computer program source deck that is designed for multiple regression analysis employing the technique of stepwise deletion in the search for most significant variables. The features of the program, along with inputs and outputs, are briefly described, with a note on machine compatibility.

MULGRES is a new user-oriented computer program for multiple regression analysis.

Regression programs have been with us for some time, but generally they are of the canned variety at a computer center. Most programs of this type are efficient in terms of computer time and money, but they usually require an adjustment period for the user to gain familiarization with control cards, input of data, etc. Some can be baffling to the non-programmer and may require consultation with members of the computer staff or with other users.

A second difficulty with canned programs arises when you change job locations or for other reasons must use a new computer facility. Changing your computer hardware usually means changing the software as well; and you must now learn the idiosyncrasies of a new system. You will have to read a new user's manual, become familiar with new system control cards, a new data format, and a new presentation of the output.

Another feature of the canned library version—objectionable to many analysts—is lack of accessibility to the program's internal structure. Frequently the user would like to change the program to suit his personal whims. He might wish to modify the output format (adding labels, rearranging results, placing items in publishable form, etc.), add sections to compute other statistics, delete portions, or change the manner of inputting data. Such flexibility is impossible with the canned program because it is stored on magnetic tape or as an object deck and is inaccessible to the user.

MULGRES attempts to alleviate the first problem and definitely solves the last two difficulties. The input requirements are short and simple to apply; and once learned they will not become obsolete because the user will have his own copy of the program source deck and can quickly adapt it for use at any computer center. These features are helpful when one considers the importance of regression analysis in the various areas of research. Effort should be spent analyzing data and interpreting results—not on analyzing computer programs and interpreting their instructions.

Features of MULGRES

1. The program is coded in FORTRAN IV.
2. One scratch or work tape is required.
3. The maximum capacity of the program is 15 variables and 600 observations on each. However, it is possible to alter the DIMENSION statement to include either more variables (and fewer observations) or more observations (and fewer variables).
4. A variable format approach is used for data input. This permits the user to prepare a FORMAT card to suit his data, rather than forcing his data (which may have been previously punched on cards) to conform to fixed format specifications.
5. The computation procedure for performing the regression analysis is the Abbreviated Doolittle Method (*Ezekiel and Fox 1959; and Ostle 1963*).
6. A 3-way option is available so that the user may:
 - a. Perform a regression analysis utilizing stepwise deletion (*Draper and Smith 1966, Mantel 1970*). This approach involves a repetitive solving of the problem, starting with all variables in the solution. Next, the least significant variable is removed and the

analysis is repeated; and this process is continued until only one independent variable remains. Significance is based on the absolute value of the respective beta coefficients for each variable (*Ezekiel and Fox 1959*).

- b. Choose not to use the stepwise procedure and instead select specific variables to be removed from the analysis. This is useful when the researcher wishes to duplicate a previous analysis, using only the most significant variables, or to examine variable combinations not included in the stepwise deletion. This option does not require the preparation of a new FORMAT card — a time-saving feature, especially for those who obtained help in writing the original specifications.
- c. Perform a straightforward regression analysis on all independent variables with no deletions.
7. Nine common transformations are available in the program (X^2 , $1/X$, Log X , etc.) and are selected by appropriate codes. These may be used separately or in combination on any or all of the variables. This option permits the original values to be replaced by new values; or the old values may be saved and new variables may be created as well.
8. MULGRES is structured to permit the stacking or batching of any number of problems in a single computer run. A separate data deck is required for each problem; these are grouped with the source deck for analysis.
9. The program provides for detailed labeling of all printed output.

MULGRES Inputs

1. Problem title.
2. Number of observations.
3. Number of independent variables.
4. Codes for performing transformations — optional.
5. Codes for deletion alternatives — optional.
6. Variable format for reading in the data.
7. Alphanumeric labels for the independent variables.
8. Units of measure for independent variables.
9. Alphanumeric label for the dependent variable.
10. Units of measure for the dependent variable.
11. Data values for the dependent and all independent variables.
12. An end-of-problem indicator.

MULGRES Outputs

1. The first observation on each variable.
2. The transformation code and the variables so changed — when applicable.
3. The variables deleted from the analysis — when applicable.
4. Means and standard deviations for each variable.
5. The coefficient of variation for each variable.
6. Simple correlation coefficients between the dependent variable and all independent variables.
7. Simple correlation coefficients between all independent variables.
8. The matrix elements from the Doolittle solution.
9. Analysis-of-variance table.
10. Multiple correlation coefficient — R.
11. Coefficient of determination — R^2 .
12. Regression coefficients, with their:
 - a. Standard errors.
 - b. T-values for testing significance.
 - c. Beta coefficients.
13. Standard error of the estimate.
14. A table of observed Y values, predicted Y values, and the corresponding residuals.
15. The Durbin-Watson coefficient for determining the existence of serial correlation (*Salzman 1968*).

Machine Compatibility

The MULGRES program was written in FORTRAN IV specifically for the IBM System/360, Model 65 Computer. However, it can be adapted readily to most computers simply by changing the system control cards, logical unit numbers for the READ and WRITE statements (if necessary), and supplying the appropriate scratch-tape unit number. These unit numbers are defined at the beginning of the source program, hence only three numbers would need to be changed to insure hardware compatibility.

Program Availability

Complete program documentation is available upon request from the USDA Forest Products Marketing Laboratory at Princeton, West Virginia. It includes a user's manual (containing a program listing, flow chart, list of variables, input instructions, diagram of deck structure, sample input, and sample output), punched copies of the source deck, and a sample problem deck.

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